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NASA TECH BRIEF

Two-Axis Flux Gate Magnetometer

Magnetometers have proven useful in a variety of applications for measuring the direction and intensity of weak magnetic fields. Typical examples of these applications are electronic compasses where the earth's magnetic field direction is measured. In the case of a spinning body, a two-axis magnetometer can determine all components of the field as well as their relative orientation with respect to the spin axis. In addition, such devices have been used as sensors at street intersections to cycle traffic lights in relation to direction of predominant traffic flow. Recently, commercial airlines have found use for the devices in detecting ferrous metal objects carried on the persons or in the luggage of boarding passengers.

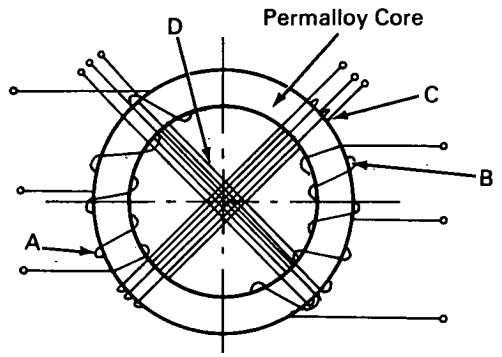

Figure 1. Sensor Head

Prior art flux gate magnetometers have required a separate magnetic sensing head for each axis along which a magnetic field is to be measured. Typically, these heads are driven by separate oscillators so that a magnetic field passing through a sensing head at an appropriate angle causes an imbalance in the output of the sense windings about the head. This imbalance causes the sense windings to generate a second-harmonic signal that is phase-compared with the output of a frequency doubler excited by the drive oscillator. The output from the phase-comparison device indicates the direction and magnitude of the magnetic field passing through the head. These magnetometers are quite bulky and expensive, and they require appreciable power inputs.

A novel flux gate magnetometer has been designed that measures, by means of a single sensing head, magnetic flux density along two axes simultaneously. The magnetometer performs the same functions as the previously discussed more complex devices, costs much less to produce, and effects a size reduction of approximately 12 to 1.

Figure 1 illustrates the sensor head, which consists of a permalloy core around which four windings are mounted. Windings A and B, in conjunction with suitable electronic circuitry, perform a multivibrator function while windings C and D are sensor windings arranged to sense magnetic fields along two axes. In operation (Fig. 2), the magnetic multivibrator provides the oscillating magnetic flux necessary to drive the permalloy core into saturation alternately in opposite directions. This is done in a conventional manner by switching a pair of transistors on and off at a rate determined by the design of the permalloy core, the number of turns in the windings A and B, and the voltage level applied by the voltage regulator. The square wave produced by the magnetic multivibrator is doubled by the frequency doubler and applied as a reference signal to each phase detector, A and B. A second-harmonic signal, proportional in amplitude to the magnetic flux density along their axes, is induced in core windings C and D and then applied to the signal inputs of phase detectors 1 and 2, respectively.

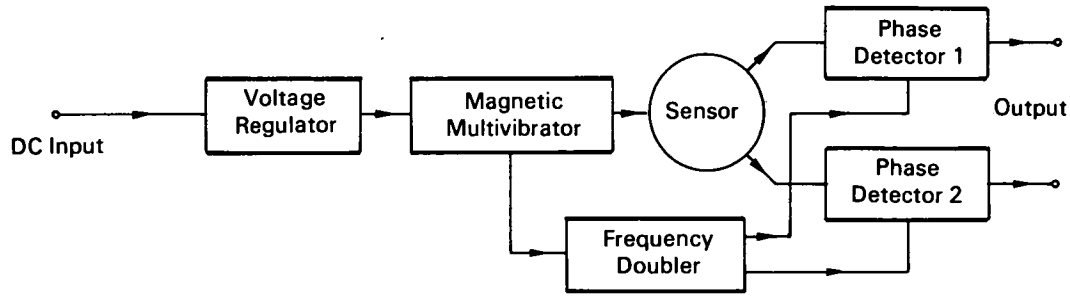

Figure 2. Magnetometer Circuitry

The phase detectors compare the second-harmonic signals from windings C and D to the reference signals from the frequency doubler. At the same time they rectify the second-harmonic signals to produce a dc voltage proportional to the flux density along core windings C and D at each of the output terminals. Since these dc output voltages are positive or negative, depending on the direction of the magnetic field sensed by windings C and D, both the magnitude and direction of the field are determined along each of the two axes simultaneously.

Notes:

1. A possible application would be in the north-seeking, attitude control systems for buoys used in oceanographic or meteorological data gathering systems.
2. Requests for further documentation may be directed to:
   Technology Utilization Officer
   Goddard Space Flight Center
   Code 207.1
   Greenbelt, Maryland 20771
   Reference: TSP70-10345

Patent status:

This invention is owned by NASA, and a patent application has been filed. Royalty-free, nonexclusive licenses for its commercial use will be granted by NASA. Inquiries concerning license rights should be made to NASA, Code GP, Washington, D.C. 20546.

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